THREE-DIMENSIONAL STRUCTURE AND EVOLUTION OF PROPAGATING DISTURBANCES IN THE MARINE LAYER OFF THE U.S. WEST COAST: ANALYSIS OF 1996 AIRCRAFT OBSERVATION

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LONG TERM GOALS

This project is part of the Coastal Meteorology Accelerated Research Initiative (ARI), and as such has the following long-term goal: To develop an understanding of the genesis, propagation and decay of coastally trapped disturbances (CTDs) along mountainous coastlines.

OBJECTIVES

The meteorological focus in this ARI is the propagating, coastally trapped southerly surge, which typically occurs several times each summer season along the U.S. west coast. During the time our instrumented aircraft was on the west coast (June 1994, and late May through September 1996) there were six southerly wind episodes: the June 1994 event was a southerly surge that lasted approximately two days, three of the 1996 episodes had a surge component, one event should have produced a southerly surge but did not, and one event was a transition to synoptic scale southerlies without a surge component. Our principal scientific activity in the present grant is to use these new data to obtain a more definitive view of the three-dimensional spatial structure of southerly surges.

APPROACH

Our flights have gathered the only data set that can provide a direct look into the anatomy of the airflow and stratification over the coastal waters during a southerly surge. Towards this end, vertical sections of potential temperature and wind velocity have been constructed showing “slices” through the four surge cases. In addition to revealing this structure, the continuous wind velocity, temperature and humidity profiles measured by the aircraft can give accurate and continuous profiles of stratification, Richardson number and Froude number.

WORK COMPLETED

All 1996 data are being processed in essentially the same fashion as were the 1994 data [*Bane at al.*, 1995]. This involves editing and cleaning the data sets to eliminate clearly bad data values, aligning all data time series to a common time standard, conversion of measured

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variables to scientific units using calibration information, and computation of atmospheric variables from measured variables (*e.g.* the wind computation requires the combination of several measured variables, including aircraft heading and airspeed, air temperature, air pressure, aircraft groundtrack and groundspeed). During FY 1997 all data sets were transferred from the aircraft computers to the workstations in Chapel Hill, and initial processing steps were applied in order to provide first looks at some of the more interesting cases. Refinements to several sections inproved the quality of the data presentation, and these sections are now displayedon our project website [http://www.marine.unc.edu/cool/mbl/] and have been discussed in the publications listed below.

RESULTS

The four southerly surge cases that we now have measured include two surges between Point Conception and Point Reyes (June 1994 and June 1996) and two surges between Point Reyes and Cape Blanco (July and September 1996). Temperature and velocity sections from these surges suggest that each has a southerly flow leading edge above the MBL, similar to that first seen in the June 1994 case. Should this prove to be correct following a thorough reconstruction of the 1996 sections, this would strengthen the notion that the complex vertical structure observed in June 1994 is the typical situation as opposed to an isolated occurrence. A correct dynamical understanding must then include an explanation of this structure. Several presentations have been made at AGU, AMS and Navy meetings, and Proceedings papers written on these findings [*Bane*, 1996, 1997a,b; *Bane and Armi*, 1996; *Ralph et al.*, 1996; and *Thompson and Bane,* 1998]. Two journal articles are in press [*Dorman et al.*, 1998; and *Ralph et al.*, 1998], and an overview article describing the Coastal Meteorology ARI is in preparation [*Nuss et al.*, 1998].

IMPACT

Already we are beginning to refine our view of the dynamical nature of these events based on the aircraft sections. Structural comparisons among four surges were discussed by *Bane* [1996, 1997a,b], and the structural features of the June 1994 event were compared with non-linear Kelvin Wave theory in *Ralph et al.* [1996]. The new aspect of the *Ralph et al.* study is that it describes the surge to be a Kelvin wave in the marine boundary layer inversion (MBLI) as opposed to a wave within the marine boundary layer (MBL) itself. The MBL retains a constant thickness throughout the event, whereas the MBLI supports a wave propagating over a rigid lower boundary, which is the top of the MBL immediately below the MBLI. In other words, it is the MBLI that is the active participant in the surge and the MBL, or surface layer, follows the development of the wave in the MBLI.

TRANSITIONS

Comparisons between our aircraft surge observations and COAMPS simulations of these events produced at NRL-Monterey are being made. The first comparisons, on two of the four cases, are reported in *Thompson and Bane* [1998]. The structural features in the observed and simulated wind and temperature fields are quite similar, but differences in detail suggest that the COAMPS simulations may be improved even further. This work is continuing, with the aims of understanding the model-observational differences and providing the best possible forecasts.

RELATED PROJECTS

The collection and analysis of the data in this project have been coordinated with the other investigations supported by the Coastal Meteorology ARI. Additional collaborations have been established with the NSF-supported *Coastal Waves* 96 project of David Rogers and Clive Dorman [*Rogers et al.*, 1998], and we have been working closely with William Thompson at NRL-Monterey on the model-data comparisons described above.

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Website for this project at the University of North Carolina: http://www.marine.unc.edu.cool/mbl/